PATENT SPECIFICATION

(11) 1 536 663

1 536 663

(21) Application No. 46451/74 (22) Filed 28 Oct. 1974

(23) Complete Specification filed 28 Oct. 1975

(44) Complete Specification published 20 Dec. 1978

(51) INT CL[2] C04B 31/00

(52) Index at acceptance

C3N 3A2A 3A2B 3A2C 3A2X 3A3E 3A3G 3A3K 3A3P 3A3Q 3A3S 3A3U 3A3X 3B3 3C

D2B 11A1 11A2 11AY 36F2 36J1 37 38 41A

(19)

(72) Inventors ROBERT CHARLES MOORE and ANDREW JELEN

(54) FIBRE-REINFORCED ARTICLES

(71) We, CAPE BOARDS AND PANELS LIMITED, a Company organised under the laws of Great Britain of Iver Lane, Uxbridge UB8 2JQ, Middlesex, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to fibre-reinforced articles, and especially to fibre-reinforced gypsum plaster boards, which have good strength and fire resistance properties.

According to the invention a board is made from a mixture comprising gypsum plaster, fibrous mineral reinforcement and from 1 to 25% by weight, based on the solids content of the composition, of a cellulosic fibrous material.

Also according to the invention a method of making a board comprises forming into shape an aqueous slurry of gypsum plaster, fibrous mineral reinforcement and from 1 to 25% by weight, based on the solids content of the composition, of a cellulosic fibrous material, removing any excess water therefrom, and causing or allowing the resultant material to set.

Gypsum plaster is calcium sulphate, both in the anhydrous and hydrated form, and a very suitable material for use in this invention is the hemi-hydrate. Both the α- and β-forms of the hemi-hydrated material may be used in accordance with this invention, as may mixtures of the α- and β-forms.

Suitable fibrous mineral reinforcement materials include glass wool, glass fibres, glass strands and glass filaments, for example of "E" glass (a low alkali borosilicate glass), and ceramic fibres, but preferred mineral reinforcement materials are mineral wool fibres such as rock wool and slag wool fibres. The rock wool fibres sold under the trade mark "Rocksil" are particularly preferred, since they have good dispersion characteristics, high temperature resistance, good tensile strength, and are relatively inexpensive.

A further suitable reinforcement material is asbestos, the fibres of which, in its different forms, may be used in accordance with the invention. Clearly, however, in those cases where the material is required to be free of asbestos, the reinforcement materials listed in the previous paragraph would more suitably be used.

Suitable cellulosic fibrous materials include cellulose itself and its derivatives, newsprint, bleached and unbleached paper pulp, sisal, cotton, wood chips, jute, hemp, straw and ramie, inter alia.

Products of widely differing strength, density and fire-resistance properties, suitable for example as wall boards and ceiling panels, may be produced by varying the proportions of ingredients used in the mix. The solids content of the mix (i.e. disregarding the water used in the formation of the slurry) comprises from 1 to 25%, preferably from 2.5 to 20%, by weight of cellulosic material, and suitably from 1 to 25%, preferably 2.5 to 20%, by weight of fibrous mineral reinforcement, the balance to 100% being gypsum plaster and any further desired additives as mentioned hereinbelow.

The shaped products of the invention may be formed by forming an aqueous slurry of the ingredients, forming this slurry into the desired shape, removing water as necessary, allowing the plaster to cure, and drying the product. Various water to solids ratios are suitable for the mix, depending upon the technique utilised in the production of the shaped final product. Generally speaking, the water:solids weight ratio will be in the range up to 20:1, the lower limit being determined by the minimum amount of water which is necessary for mixing and to set the plaster during curing of the shaped article. (As is known, different plasters have different water requirements.) Water:solids ratios in the range 5:1 to 10:1 are particularly suitable for some forming techniques, and in others water:solids ratios from 0.4:1 to 1:1 are preferred.

After thorough mixing of the slurry, this is passed into a forming machine, which may be

a mould or a continuous board forming machine such as a Magnani, Hatschek or Fourdrinier machine. These latter machines are best suited for high water/solids ratios mixes; for lower water/solids ratio mixes it may be preferable to extrude the mix, or, for example, to charge a low water-content slurry from, for example, a paddle mixer directly onto a moving belt upon which it is subsequently compacted by the action of one of a series of suitably positioned press rollers, into the desired shape. After compaction it is allowed to set to a dry state.

When using this latter forming technique it is preferable to use, in the formation of the slurry, the minimum amount of water which is required for mixing and to set the plaster, in order that no de-watering of the shaped slurry is necessary.

Where excess water is used in the formation of the slurry, i.e. when relatively high water/solids mixes are used, excess water is removed therefrom during or after shaping of the slurry, for example by suction, and the resulting material is then cured and dried to give the finished product.

In another method according to the invention, for the continuous production of a fibre-reinforced plaster board, a preformed slurry of plaster and cellulosic material may be delivered onto a continuously moving conveyor, or onto a backing (e.g. paper) sheet placed thereon if desired, the fibrous mineral reinforcement being introduced, e.g. sprayed, in the dry state into this slurry a short distance downstream of the point of delivery of the slurry. Water is removed from the mixture, which is compressed against the conveyor as it starts to set. Partially set board can be removed from the conveyor, cut up as desired and stored while it is setting.

It should be noted that, apart from the three main ingredients recited above, the slurry, and therefore the final products, may contain other additives known in the art of making plaster products. These may include for example:—

a) Accelerators, retarders, flocculants;
b) Waterproofing agents—e.g. resins in emulsion form;
c) Filter aids and fillers such as vermiculite, perlite and expanded clay.

The mixtures recited above are eminently suitable for the production of flat boards and panels with good strength and fire resistance, for example for use in the building and shipbuilding industries. They are also useful, however, for the production of other board materials, such as corrugated sheets and cladding panels. Although boards made from the composition of the invention may, if desired, be provided with facing and/or backing sheets, for example of paper, it is an important advantage of the composition of the invention that the presence of the cellulosic material in it renders the use of backing/facing sheets unnecessary.

The following Examples are given for the purpose of illustrating the invention, and to exemplify the invention the production of fibre-reinforced gypsum boards has been carried out on a pilot scale using press, Hatschek and Fourdrinier methods.

Example 1
Press Method

Waste newsprint was beaten with water for 45 minutes in a small scale Hydrapulper to break down the paper and give a smooth slurry. "Rocksil" rock wool building mat waste was then added to give the desired cellulose: "Rocksil" ratio and the mix was hydrapulped for a further 15 minutes to mix the fibres thoroughly. At this stage the water: fibre weight ratio was usually in the range 30:1 to 80:1, depending on the desired fibre content and density of the board to be produced. The fibre slurry was then batched by weight as required, depending on the desired density, thickness and fibre content of the board to be produced on the 18"×18" pilot dewatering press.

The necessary amount of hemihydrate plaster was mixed to a smooth paste with a little water and then dispersed thoroughly in the fibre slurry. Flocculant solution was added at this stage to reduce powder losses during filtration and the fibre/plaster mix was then spread evenly in the dewatering press and suction applied to remove water.

When most of the water had been removed the press was closed to compact the board to the required thickness. The pressures used ranged from a few pounds up to about 1100 pounds per square inch, depending on the final board density. Suction was maintained during the pressing operation and when no more water could be removed from the board the latter was removed from the press and placed between two flat boards to allow the plaster to harden. After 6 hours the board was dried overnight in a ventilated oven maintained at 40°C.

This method allowed the production of boards with a range of densities, thicknesses and compositions. Three typical examples are given below:—

a) 20 Kgs fibre slurry (4.75 gms newsprint (cellulosic) and 12 gms "Rocksil" (rock wool) per 1000 gms water)
1600* gms retarded β-hemihydrate plaster
70 ppm Magnafloc R156 (based on solids weight) added as 0.025% aqueous solution.
Water/Solids weight ratio 10.3:1
This gave a dry board 457 mm×457 mm×9.5 mm with a density of 960

Kg/m^3 and containing 5% newsprint and 12.5% "Rocksil", by weight. Typical Moduli of Rupture (3—point loading) were 4.4—8.3 N/mm^2 in the density range 880—1070 Kg/m^3.

b) 13.6 Kgs fibre slurry (12 gms newsprint and 9 gms "Rocksil" per 1000 gms water)
1300* gms unretarded α-hemihydrate plaster
120 ppm Magnafloc R156 (added as 0.025% aq. solution)
Water/solids weight ratio 8.6:1
This gave a dry board 457 mm×456 mm×9.5 mm with a density of 800 Kg/m^3 and containing 10% newsprint and 7-1/2% "Rocksil", by weight.
Modulus of Rupture data for boards of this type were 4.3—9.6 N/mm^2 in the density range 800—1070 Kg/m^3.

c) 10.8 Kgs fiber slurry (5 gms newsprint and 21 gms "Rocksil" per 1000 g water).
1500* gms retarded β-hemihydrate plaster
160 ppm Magnafloc R 156 (added as 0.025% aq. solution)
Water: Solids weight ratio 5.9:1
This gave a board measuring 457 mm×457 mm×9.5 mm with a density of 880 Kg/m^3 and containing 3% newsprint and 12.5% Rocksil, by weight.
Modulus of Rupture data for boards of this composition ranged from 2.9 to 6.4 N/mm^2 at densities between 770 and 990 Kg/m^3.

Example 2
Hatschek Method

For Hatschek boards the newsprint/"Rocksil" fibre slurry was prepared in the manner described in Example 1 with the cellulosic and mineral fibres mixed in the desired proportions. The required quantity of retarded β-hemihydrate plaster was then added and dispersed thoroughly by hydrapulping the mix for 5 minutes. For Hatschek running the initial water:solids weight ratio of the slurry was normally 10:1, but this was usually altered as necessary by addition of dilution water in the machine vat. The slurry was then transferred to the stuff-chest of a pilot Hatschek machine and boards were made in a manner similar to that used for conventional asbestos-reinforced calcium silicate and cement boards. Magnafloc R 156 solution (0.025% W/W) was added to the machine vat to minimise powder losses at the cylinder wire. Production rate, dilution water, roll pressure and suction level were adjusted to the filtration and running characteristics of the mix.

The boards were cured and dried in the standard way.

d) Typical physical data for Hatschek-produced gypsum boards containing 7-1/2% newsprint and 10% "Rocksil" by weight, were:

Density:	790—850 Kg/m^3
Modulus of Rupture:	
With Grain:	0.9—5.2 N/mm^2
Across Grain:	5.9—6.5 N/mm^2
Impact Strength: (Charpy test)	
With Grain:	1.0 J/mm
Across Grain:	1.3 J/mm

Example 3
Fourdrinier Method

Boards were produced on a pilot Fourdrinier machine in a manner similar to that normally used for the production of mineral fibre acoustic panels. The mixes were prepared as described for Hatschek running but the water:solids ratio was restricted to about 5:1. The wire speed, suction levels and roll settings were adjusted according to the running characteristics of the mix.

Typical Modulus of Rupture figures for boards produced on the Fourdrinier machine and containing, by weight, 7-1/2% newsprint and 12-1/2% Rocksil were 2.0 5.5 N/mm^2 in the density range 650 850 Kg/m^3.

WHAT WE CLAIM IS:—

1. A board made from a composition comprising gypsum plaster, fibrous mineral reinforcement and from 1 to 25% by weight, based on the solids content of the composition, of a cellulosic fibrous material.

2. A board as claimed in claim 1 wherein the cellulosic material is present in an amount of 2.5 to 20%, on the same basis.

3. A board as claimed in claim 1 or 2 wherein the fibrous mineral reinforcement is present in an amount of 1 to 25% by weight, based on the solids content of the composition.

4. A board as claimed in claim 3, wherein the fibrous mineral reinforcement is present in an amount of 2.5 to 20%, on the same basis.

5. A board as claimed in any of claims 1 to 4 wherein the fibrous mineral reinforcement includes one or more of glass wool, glass fibres, glass strands, glass filaments, ceramic fibres, mineral wool fibres and asbestos fibres.

(* The actual weight of plaster used was slightly greater than the theoretical quantity to allow for the solubility of the hemihydrate and for slight losses during pressing.)

6. A board as claimed in claim 5 wherein the fibrous mineral reinforcement comprises rock wool or slag wool.

7. A board as claimed in any of claims 1 to 6 wherein the cellulosic material comprises one or more of cellulose, cellulose derivatives, newsprint, bleached and unbleached paper pulp, sisal, cotton, wood chips, jute, hemp, straw and ramie.

8. A board as claimed in any of claims 1 to 7, wherein the composition is in the form of an aqueous slurry.

9. A board as claimed in claim 8 wherein the water:solids weight ratio of the slurry is in the range up to 20:1.

10. A board as claimed in claim 9 wherein the water:solids ratio of the slurry is in the range 5:1 to 10:1.

11. A board as claimed in claim 9 wherein the water/solids artio of the slurry is in the range 0.4:1 to 1:1.

12. A board as claimed in any of claims 1 to 11 wherein the composition also includes one or more of the following:—

a setting accelerator or retarder, a flocculant, a water-proofing agent, a filter aid, a filler.

13. A board as claimed in claim 1, substantially as hereinbefore described.

14. A method of making a board which comprises forming into shape an aqueous slurry including gypsum plaster, fibrous mineral reinforcement and from 1 to 25% by weight, based on the solids content of the composition, of a cellulosic fibrous material, removing any excess water therefrom, and causing or allowing the resultant material to set.

15. A method as claimed in claim 14 comprising (i) delivering onto a continuously moving conveyor, or onto a backing sheet placed thereon, an aqueous slurry of gypsum plaster and cellulosic fibrous material, (ii) introducing into said slurry, at a position downstream of the point of delivery of the slurry onto the conveyor or backing sheet, fibrous mineral reinforcement, (iii) removing water from the mixture, and (iv) compressing the slurry against the conveyor whilst the slurry is caused or allowed, at least partially to set.

16. A method as claimed in claim 14, substantially as described in any of the Examples.

For the Applicants:
CARPMAELS & RANSFORD,
Chartered Patent Agents,
43, Bloomsbury Square,
London, WC1A 2RA.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1978
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.